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SELECTING A PROGRAM FOR BUTTERFAT SAMPLING

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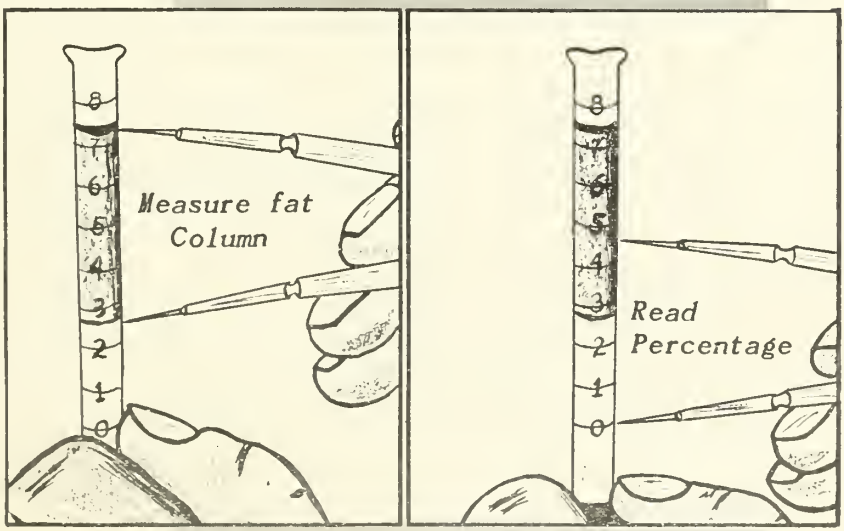
BY ROMER J. PRESTON



U. S. Department of Agriculture
Farmer Cooperative Service
Washington 25, D. C.

FCS Circular 11
March 1956

THE Farmer Cooperative Service conducts research studies and service activities of assistance to farmers in connection with cooperatives engaged in marketing farm products, purchasing farm supplies, and supplying business services. The work of the Service relates to problems of management, organization, policies, financing, merchandising, product quality, costs, efficiency, and membership.

The Service publishes the results of the studies; confers and advises with officials of farmer cooperatives; and works with educational agencies, cooperatives, and others in the dissemination of information relating to cooperative principles and practices.

JOSEPH G. KNAPP,
Administrator,
Farmer Cooperative Service,
U. S. Department of Agriculture.

This study was conducted under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

CONTENTS

	Page
How we made the study	2
What we learned	2
Sampling problems	2
Selecting the sampling-testing program	4
Estimating the cost	5
Check testing the program	6
Our recommendations	6
Appendix	9

FCS Circular 11 **March 1956**

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SELECTING A PROGRAM FOR BUTTERFAT SAMPLING

By Homer J. Preston
Marketing Division

A DAIRY plant pays the producer for his fluid milk on the basis of butterfat content as well as volume. Therefore the returns of both milk plant and producer depend on accurate butterfat sampling and testing. In addition, the producer's confidence in the integrity of a dairy plant's management is measured largely by his faith in the station's sampling and testing practices.

Many dairy cooperatives have testing problems. Perhaps the milk plant's testing program is inadequate. The plant manager, together with the cooperative's directors, may wish to develop a better sampling-testing method. But deciding which of the various programs will best meet the plant's needs and those of the producers is difficult without full knowledge of the effectiveness and costs of each.

The Dairy Branch, Farmer Cooperative Service, recently made a study of several sampling and testing methods. Our complete findings are available in FCS Bulletin 5, "Developing Butterfat Sampling and Testing Programs."

FCS Bulletin 5 is useful to plant managers who often recommend which program to adopt and especially to researchers interested in the technical details of determining the comparative degrees of accuracy and the corresponding costs of sampling-testing programs.

This shorter circular gives in brief the conclusions derived from our study and the recommendations based on that study. It omits the statistical methodology by which those conclusions were reached. It, too, will be useful to plant managers who wish to assess the effectiveness of their present testing program or to consider the advisability of adopting a different one. It is a simple reference tool that can be placed in the hands of milk testers and fieldmen. And because the producer patrons, acting through their directors, make the final policy decision on sampling-testing programs, it will be of interest to those producers.

Acknowledgment: Sarah C. Saunders, Information Division, is primarily responsible for summarizing and adapting the discussion in FCS Bulletin 5, "Developing Butterfat Sampling and Testing Programs," to provide this less technical report.

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How We Made the Study

OUR study was made under actual receiving conditions. Michigan Milk Producers Association, Detroit, cooperated with us. Over a period of 14 months their experienced licensed testers ran the tests at the Ortonville, Mich., receiving station and turned results over to us. Of this station's producer patrons, 100 were selected for the tests because they showed sufficient range in volume of milk and in butterfat content to represent normal operating conditions for a sampling-testing program.

Our chief purpose in making different kinds of tests was to compare test results and costs of the testing programs. Personnel assigned to the study ran daily fresh tests and also combined daily samples to make 7-day, 10-day, and 15-day composites.

The appendix shows complete instructions given to testing personnel for running Babcock tests for butterfat content. Dairy Husbandry staffs from Michigan State University and The Pennsylvania State University approved the instructions. Purdue University checked and certified the accuracy of all glassware used.

What We Learned

AFTER examining daily and composite test results of the 100 producers for 14 months, we were able to point out specific problems in sampling, to show available choices among sampling-testing programs, to supply approximate costs of operating a sampling-testing program, and to suggest methods of checking the accuracy of such a program after it has been adopted and used.

Sampling Problems

The milk of every producer varied in butterfat content from day to day. This variation resulted from one or more of the following causes:

This is the Ortonville, Mich., receiving station where testers from Michigan Milk Producers Association, Detroit, ran the tests.

Healthy cows well cared for are likely to produce milk with less variation in butterfat content.

1. Daily changes in the herd's butterfat content.

2. Inadequate blending in the weigh tank.

3. Differences in sampling-testing procedures caused by normal human variability in conducting the tests.

Daily changes in herd's butterfat content. The chief causes for this variation are well known. Among them are differences in breed, in individual cows, in feeding and milking practices, and in overall care and handling of cows. Our study proved that the amount of variability from these causes was much greater than from either of the other two mentioned.

The amount of test variation for a given producer changed from month to month but the change was minor. An individual dairy farmer was likely to be consistent in remaining a high, a medium, or a low variability producer.

In any representative group, if the average producer has an average test of 4 percent, his monthly variability range is likely to be about as follows:

For 20 days the butterfat content of his milk will test from 3.8 to 4.2 percent. For 5 days it will be below 3.8 and for 5 days it will be above 4.2 percent. About 60 percent of all producers in a representative group will show this much variation or less. They are the medium variability group.

The low variability producer with an average test of 4 percent is likely to have tests ranging from 3.9 to 4.1 percent for 20 days. About 10 percent of the producers being tested will fall within this range, if the group is similar to the one on which our study was based.

The high variability producer with an average test of 4 percent is likely to have tests ranging from 3.6 to 4.4 percent for 20 days. In this group are the low volume producers. They make up the problem group, but they include fewer than 10 percent of the total.

Inadequate blending. The samples we took from five different positions in the weigh tank proved that inadequate blending causes variations in butterfat content. (See appendix figure 1 for a diagram showing posi-

tions from which we took samples.)

We were able to decrease overall variability in butterfat content by having a "false hopper" device installed in the dump hopper of the weigh tank used in our study. This device reduced to 5 inches in diameter the opening through which milk flowed into the main portion of the weigh tank. It increased the slope and therefore the velocity of milk as it entered the main portion of the weigh tank. Thus it helped to blend the milk more adequately. (See appendix figure 2 for a blueprint of the false hopper device.)

If milk in the weigh tank is not well blended, samples obtained may give a consistently higher or lower butterfat test than the actual butterfat content and thus increase variability.

Sampling - testing procedures. From other studies we know that some variation almost invariably results from the procedures used. By prescribed procedures and close supervision we reduced this variation to a minimum. There probably always will be some variation, however, because of the nature of the test itself and the human error in conducting it.

Selecting the Sampling-Testing Program

The most important step in developing a sampling-testing program is to select one that is accurate enough to insure producer confidence and yet is not prohibitive in cost.

We studied these several programs:

Daily samples. Only a program of daily fresh sampling of adequately blended milk will give the actual butterfat content, but such a program is costly. It requires increased facilities and personnel.

Fresh samples taken at intervals of several days. One compromise between accuracy and cost is a limited number of fresh samples taken at intervals of several days. Tests made less often than daily will generally be more accurate if uniformly distributed throughout the month.

The Babcock test with a limited number of fresh samples estimates the true butterfat content. This estimate may be slightly above or below the actual butterfat content for a given month, but for a longer period the variations are likely to balance out. The greater the number of samples within a given month, the closer this estimate will be to the real butterfat content.

Composites. Another compromise between accuracy of test and cost of program lies in composite tests. These are likely to underestimate butterfat content.

In our study we made over 600 comparisons between composites and averages of fresh samples for the corresponding period. These comparisons showed that the 7-day composite was below the fresh tests 63 percent of the time; the 10-day composite was below 69 percent of the time; and the 15-day composite was below 73 percent of the time.

Composites had a greater drop in test as length of compositing period increased. We found when the average of daily fresh samples was 3.922 percent for the period studied, the average of the 7-day composites was 3.915 percent, of the 10-day composites 3.908 percent, and of the 15-day composites 3.901 percent. What these averages mean to the producer is this:

The 100 producers included in our study produced a total of about 11.1 million pounds of milk. We compared the averages of sampling and testing

programs consisting of an average of 5 fresh tests a month and averages of 7-day, 10-day, and 15-day composite samples for these producers. We found the value of the butterfat minus the testing costs was larger for the 5 fresh samples a month than for any of the other programs. Returns to producers above costs of testing became less as the compositing period was increased. (See appendix table 1.)

Our study also showed the drop in test was greater as average butterfat content increased. When a group of 8 producers had an average daily butterfat test of 3.27 percent, their 15-day composite was .028 percent below the daily average. A group of 8 with an average daily test of 4.67 percent had a 15-day composite test .101 percent below the daily average.

Estimating the Cost

Differences in costs among the several sampling and testing programs are due primarily to variations in the amount of labor required. As the number of tests per month for a producer increases, costs will increase. (See appendix table 2.) But costs per sample usually decline as the number of producers per plant increases. (See appendix table 3.)

Lowest cost per sample results when there are enough producers to make a full day's workload for each sampler-tester (about 200 producers per 8-hour day). Large plants with multiples of 200 producers generally can use sampler-testers efficiently. In small plants sampling-testing programs become more expensive per producer.

It takes about the same time to run tests on composites as it does to obtain and test fresh samples, if the receiving crew takes the daily samples to form the composites. In comparing costs of the various sampling-testing programs in the tables, we have used "number of samples" to refer to either composite or fresh samples.

Sampling and testing programs may

Milk from cows of different breeds may vary in butterfat content.

be developed for a market or on an individual plant basis. Program costs will vary according to size of market and size of plant. (See appendix table 4.)

Check Testing the Program

Since the producer receives payment on his milk on the basis of the receiving station's weights and tests, it is necessary that weighing and testing be as nearly accurate as possible. Either a Government or a cooperative representative may perform check tests to determine whether the station's sampling-testing practices are reasonably dependable. Such tests are usually made in limited numbers during any single pay period.

Our study showed that a limited sampling-testing program may fall slightly above or below actual butterfat content, depending upon variations in producer tests. The same is true in a check test program.

Does this mean that check tests have little value? The answer is *No,* if the check test results are used properly.

Such use includes comparing the check test results with those of the station on the basis of the plant as a whole. The average test for all producer patrons combined has only minor variations from day to day. These variations will be less when test variability for the individual producer is low and when there are a large number of producers. Where a station has a dependable sampling-testing program, plantwide check tests will probably be about equally distributed above and below the station's average producer test results.

Check tests can also detect errors in a sampling-testing program if individual check test results are compared with plant tests for individual producers. If these two comparisons reveal errors in the producer's test, the milk plant will do well to adjust its test results to the check test results.

Our Recommendations

FROM our study of different sampling-testing programs over a 14-month period, we make these suggestions for milk plant operators:

1. Select the type program that will give producers acceptable test results without prohibitive costs. This requires that you strike a balance between cost and precision of estimating the butterfat content.

We found that composite samples rather consistently underestimated butterfat content. The amount by which it was underestimated increased as (1) average level of butterfat content increased and (2) the compositing period increased.

In considering a program based upon the average test of several fresh samples we found this program did not consistently overestimate or underestimate the butterfat content. However, since butterfat tests did vary from day to day for each producer, test averages based upon a limited number of fresh tests during a month also had some variation from the actual average. We found that averages based on a limited number of fresh tests gave more precise test estimates when (1) number of fresh samples per month were increased and (2) day-to-day test variations for producers were small.

In any event the test program must consider both the probable cost of the program and the probable loss to producers by failure to have a precise estimate of the actual test. In selecting

Licensed testers run the tests to determine butterfat content.

the program, current costs of conducting tests and current butterfat values are basic considerations. Butterfat values are readily available and testing costs can be computed according to local conditions.

In addition, it is also necessary to consider the average level of butterfat tests and obtain some measure of the variability in tests of the producers you serve. Daily tests during a month will give this information precisely. Yet you can estimate amount of variability in a representative group with reasonable exactness through testing fresh samples taken at intervals of several days or through testing 7-day, 10-day, and 15-day composites. Information contained in this report will help you make the decision as to which program will best meet your needs.

2. Assist producers with high variability by having the sampler-tester use any spare time he may have from his regular duties to visit your patrons in an effort to help them remedy conditions causing high variability in butterfat content.

3. Be sure that the milk in your weigh tank is well blended before taking samples.

4. See that your sampling-testing program is well supervised and any error in method discovered and corrected whenever possible.

5. Have check tests made by dependable licensed testers. If your tests vary considerably from check tests, take steps to improve your sampling-testing program.

6. If you wish to know the statistical methods by which we determined the relative effectiveness of each sampling-testing program, write to Farmer Cooperative Service, U. S. Department of Agriculture, Washington 25, D. C., and request a copy of Bulletin 5, "Developing Butterfat Sampling and Testing Programs."

Appendix

STAFF MEMBERS from Michigan State University and The Pennsylvania State University, approved the following procedures for conducting the Babcock tests. Personnel conducting the tests followed the procedures throughout the study.

Procedures and Specifications for Sampling and Testing Milk for Butterfat Content

I. Sampling

A. A one-half pint sample of milk should be taken from the *thoroughly blended* daily deliveries of milk made by individual producers delivering milk to the receiving and cooling station at Ortonville, Mich., on routes numbers 3, 4, 8, 14, 18, and 20.

1. The one-half pint sample should be taken from the weigh can just before the milk is released to the surge tank.

2. In the case of producers delivering more than the capacity of the weigh can, the delivery should be divided into equal portions, and a one-half pint sample should be taken from each portion. The samples from the two portions should be thoroughly mixed and one-half pint of the mixed milk should be transferred to another one-half pint bottle.

3. The sampling dipper should be rinsed in thoroughly mixed milk prior to taking the sample.

4. The one-half pint samples should be made into 4 separate samples.

(a) 10 cc. into a composite sample, four of which will be made up each month, consisting of samples taken from deliveries of milk from individual producers for approximately 7 consecutive days.

(b) 10 cc. into a composite sample, three of which should be made up each month, consisting of samples taken from deliveries of milk from the individual producers for approximately 10 consecutive days.

(c) 10 cc. into a composite sample, two of which should be made up each month, consisting of samples taken from deliveries of milk from individual producers for approximately 15 consecutive days.

(d) 75 cc. into a sample to be tested on the same day that the sample is taken.

5. The original one-half pint sample should be made into the four separate samples (1) within 3 minutes from the time the sample was taken, or (2) after rotating the container in one plane until the milk is thoroughly blended, this being done within 20 minutes from the time the original sample was taken.

B. Sample bottles should be clearly identified with the route and producers' numbers.

II. Preserving composite samples

A. One corrosive sublimate tablet containing 0.3 gram of mercuric chloride should be used in each composite sample.

B. Composite samples should be stored in a refrigerator which is main-

tained at between 40 and 50 degrees F.

1. Sample should not be held out of refrigeration in excess of one hour.

III. Schedule of testing

A. *30-day month:*

1. The composites to be tested four times per month should be tested on the 7th, 15th, 22d, and 30th.

2. The composites to be tested three times per month should be tested on the 10th, 20th, and 30th.

3. The composites to be tested two times per month should be tested on the 16th and the 1st of the following month.

4. The composite samples to be tested should include a sample of the delivery made on the day of testing, in addition to samples of all deliveries made subsequent to the preceding test, with the exception of the composites to be tested twice each month. In case of the composites to be tested twice each month, the composite should *not* include the sample of the delivery made on the day of testing. Instead, the sample of the delivery made on the day of testing should be included in the composite of the subsequent period.

B. *31-day month:*

1. The composites to be tested four times a month should be tested on the 7th, 15th, 23d, and 31st.

2. The composites to be tested three times per month should be tested on the 10th, 20th, and 31st.

3. The composites to be tested two times per month should be tested on the 16th and the 1st of the following month.

4. The composite samples to be tested shall include a sample of the delivery made on the day of testing, in addition to samples of all deliveries made subsequent to the preceding test, with the exception of the composites to be tested twice each month. In the case of the composites to be tested twice a month (1) the composite consisting of samples of deliveries made during the last half of the month should *not* include the sample of the day of testing, instead the sample of the delivery made on the day of testing should be included in the composite of the subsequent period; (2) the composite consisting of samples of deliveries made during the first half of the month should include a sample of the delivery on the day of testing.

C. *29-day month:*

1. The composites to be tested four times a month should be tested on the 7th, 14th, 21st, and 29th.

2. The composites to be tested three times a month should be tested on the 9th, 19th, and 29th.

3. The composites to be tested two times a month should be tested on the 15th and the 1st of the following month.

4. The composite samples to be tested should include a sample of the delivery made on the day of testing, in addition to samples of all deliveries made subsequent to the preceding test, with the exception of the composites to be tested twice each month. In the case of the composites to be tested twice a month (1) the composite consisting of samples of deliveries made during the last half of the month should *not* include the sample of the day of testing, instead the sample of the delivery made on the day of testing should be included in the composite of the subsequent period; (2) the composite consisting of samples of deliveries made during the first half of the month should include a sample of the delivery on the day of testing.

IV. Preparing samples for testing

A. Fresh sample

1. Immerse in a water bath to slightly above the level of milk in the

bottle and heat to 95°–100° F. Water bath should be automatically controlled at 105° F.

2. Mix sample by rotating the container in one plane until the sample is thoroughly blended.

3. Pipette immediately.[1]

B. Composite samples

1. Immerse in a water bath to slightly above level of milk in bottle and heat to 95°–100° F. Water bath should be automatically controlled to hold water at 105° F.

2. Mix sample by rotating the container in one plane until the milk is thoroughly blended.

(a) If fat adheres to sides of bottles and bottom of rubber stoppers dislodge with a wiping disk.

3. Pipette immediately.[1]

V. Testing procedure

A. As soon as the sample is properly mixed (see Item IV above) fill a 17.6 ml. pipette to above the mark on the draw tube.

B. Adjust the upper surface of milk to the graduated mark on the draw tube.

C. Insert stem of pipette into neck of test bottle. Allow milk to drain not less than 10 seconds. Blow last drops from tip of test bottle.

D. Cool milk in test bottles to within the temperature range of 68°–70° F.

E. Add 17.5 cc. of sulfuric acid (standardized 1.82–1.83 Specific Gravity). Acid should be within the temperature range of 68°–70° F.

1. As acid is added the test bottle should be held at an angle and turned so that any milk which clings to the side of the neck is washed into the bulb of the test bottle.

F. Immediately after acid is added mix contents of the test bottle by gently rotating bottles for at least 3 minutes.

G. Place bottles in centrifuge and whirl bottles 5 minutes after the centrifuge has reached full speed.

H. Stop centrifuge and add soft water, the temperature of which should be 140°–160° F., until the mixture in the bulb of the test bottle is raised to just below the base of the neck of the bottle.

I. Whirl bottles 2 minutes.

J. Add soft water temperature 140°–160° F. to bring fat column within the graduated neck.

K. Whirl bottles for 1 minute to collect the fat into the neck of the bottle.

L. Immediately place bottles in a water bath which is automatically controlled at 135°–140° F. and hold for 5 minutes.

M. Remove drops of water from the neck of the test bottle and read immediately. Measure the fat column from the lowest to the highest point including the menisci.

VI. Duplicate tests

A. Duplicate tests should be made on samples showing a variation of 0.3 percent or more from the test of the sample for the preceding period, i. e., in case of fresh samples, the test of the sample of the previous day's delivery; in the case of composite samples the test of the corresponding composite sample for the preceding period.

[1] Pipetting at 90°–100° F. is a deviation from the official methods as outlined in "Official and Tentative Methods of Analysis." Since the primary interest in this study is the day-to-day variation in butterfat content of the milk, as long as all samples are measured at the same temperature no error should be introduced into the study as a result of this deviation.

VII. Equipment specifications

A. Sampling dippers

1. A one-half pint dipper for taking sample of milk delivered by producer from the weigh can.

2. A 10 cc. dipper for breaking original sample into composite samples.

B. Sample bottles

1. 8 ounce bottles with rubber stoppers permanently attached to the bottle.

(a) Should be clearly identified with the producers' numbers and route numbers.

C. Pipettes

1. Each should be so graduated that when filled to the etched line on its stem it holds 17.6 cc. of milk and delivers 18 grams or 17.5 cc. at 68° F.

2. Should be approved and certified for accuracy by the Creamery License Division, Department of Dairy Husbandy, Purdue University.

D. Test bottles

1. Should read accurately for an 18 gram sample of milk and have a total graduated face reading to 8 percent with the smallest unit of calibration being 0.1 percent.

2. Should be approved and certified for accuracy by the Creamery License Division, Department of Dairy Husbandry, Purdue University.

E. Centrifuge

1. Should be electrically driven at a speed such as to create 31 pounds of centrifugal force.

2. Chamber should be automatically maintained at a temperature of 130°–135° F.

3. Should be equipped with a speed indicator and thermometer.

F. Water baths

1. For warming samples—should be automatically controlled to hold water at 105° F.

2. For tempering fat columns—should be automatically controlled to hold water at 135°–140° F.

G. Acid measure

1. Acid bottle should be so graduated as to deliver 17.5 cc. of sulfuric acid.

Figure 1.—Diagram sketch of the weigh tank indicating the five positions from which samples were obtained to determine adequacy of blending

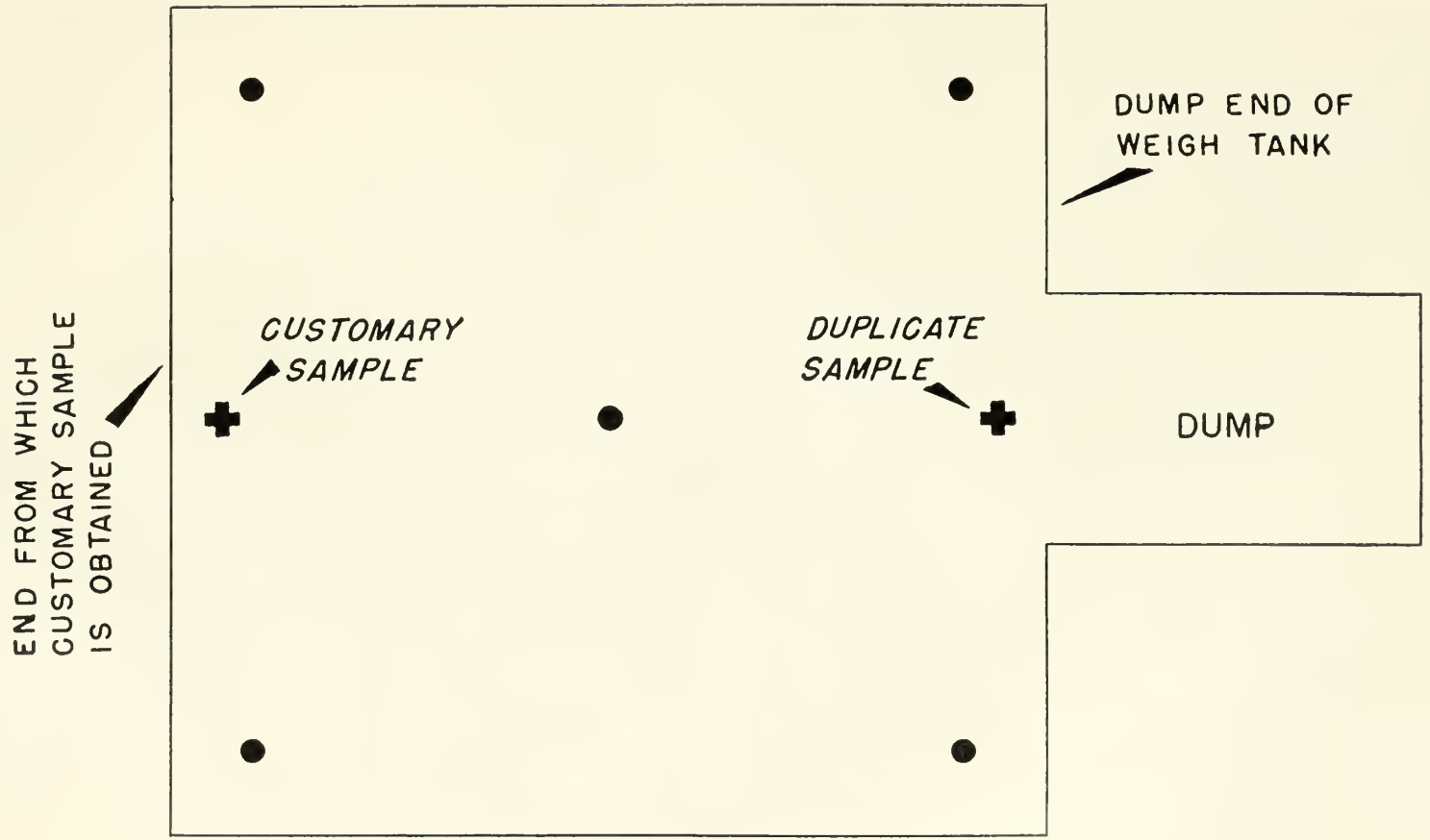
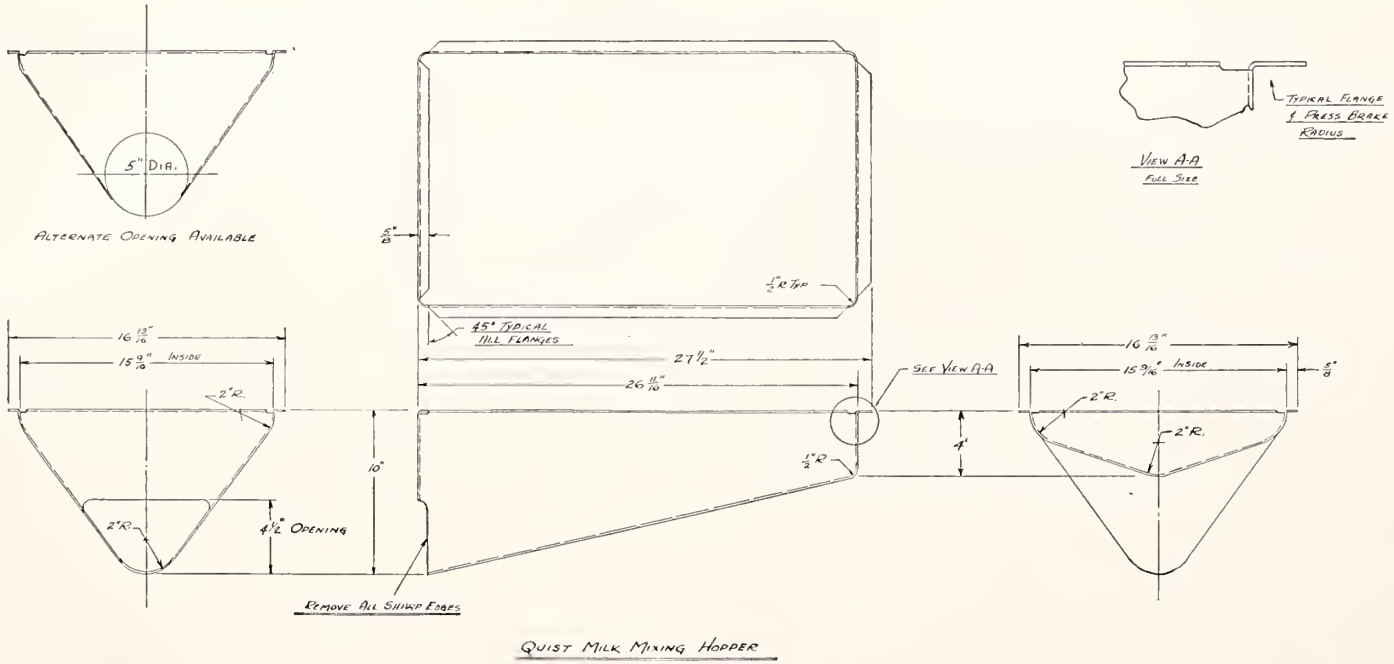


Figure 2.—Blueprint of false hopper device



MATERIAL
18-8 S STAINLESS STEEL SHEET #16 GA. TYPE 304
#4 FINISH BOTH SIDES.
ALL SEAMS WELDED INSIDE & OUTSIDE AND POLISHED TO FINISH AT LEAST EQUAL TO SHEET SURFACES.

Table 1.—Comparison of testing costs, butterfat value and producers' net returns using various sampling-testing programs, 100 producers

Type of test	Volume of milk in pounds	Percent for average test	Pounds of butterfat	Value of fat [1]	Cost of test [2]	Value of butterfat minus testing costs
5 fresh samples	11, 101, 121	3. 922	435, 386	$348, 309	$600	$347, 709
7-day composites	11, 101, 121	3. 915	434, 609	347, 687	480	347, 207
10-day composites	11, 101, 121	3. 908	433, 832	347, 066	360	346, 706
15-day composites	11, 101, 121	3. 901	453, 055	346, 444	240	346, 204

[1] Value of butterfat computed at 80 cents per pound.
[2] A cost of 10 cents was made for each milk sample tested.

Table 2.—Comparison of the cost per producer of various sampling and testing programs at 1953 prices

Producers	Cost per sample by size group	Total monthly cost per producer for testing the individual number of samples											
		2	3	4	5	6	7	8	9	10	15	20	30
Per plant													
Less than 100	$0.125	$0.250	$0.375	$0.500	$0.625	$0.750	$0.875	$1.000	$1.125	$1.250	$1.875	$2.500	$3.750
100–199	.100	.200	.300	.400	.500	.600	.700	.800	.900	1.000	1.500	2.000	3.000
200–299	.117	.234	.351	.468	.585	.702	.819	.936	1.053	1.170	1.755	2.340	3.510
300–399	.087	.174	.261	.348	.435	.522	.609	.696	.783	.870	1.305	1.740	2.610
400–499	.100	.200	.300	.400	.500	.600	.700	.800	.900	1.000	1.500	2.000	3.000
500 or over	.083	.166	.249	.332	.415	.498	.581	.664	.747	.830	1.245	1.660	2.490
Per market													
300 producers (small market)	.125	.250	.375	.500	.625	.750	.875	1.000	1.125	1.250	1.875	2.500	3.750
1,350 producers (medium market)	.105	.210	.315	.420	.525	.630	.735	.840	.945	1.050	1.575	2.100	3.150
11,400 producers (large market)	.100	.200	.300	.400	.500	.600	.700	.800	.900	1.000	1.500	2.000	3.000

Table 3.—Comparison of testing rates and costs between plants of various sizes at 1953 prices

Plant size	Rate of testing		Cost per sample in cents—		
	Hours per plant [1]	Samples per hour	Labor [2]	Other [3]	Total [4]
Number of producers:					
Less than 100	4	15	11.9	.6	12.5
100–199	8	19	9.4	.6	10.0
200–299	16	16	11.1	.6	11.7
300–399	16	22	8.1	.6	8.7
400–499	24	19	9.4	.6	10.0
500 and over [5]	24	23	7.7	.6	8.3

[1] Labor requirements are based upon full 8-hour days, but in plants with fewer than 100 producers the sampler-tester can visit 2 plants or do other types of work; that is quality or field work.

[2] Labor cost is computed on a 48-hour week at an average of $1.78 per hour.

[3] Other costs per sample include acid, test bottles, cleaning compounds and other testing materials.

[4] Total does not include the equipment and laboratory itself. This cost would generally be allocated to volume and would not be materially affected by the number of tests.

[5] Rates of testing do not materially change for plants with over 500 producers.

Source: Cost and rate of testing data were obtained from Michigan Milk Producers' Association, Detroit, Mich. Rates of testing were also obtained from Maryland and Virginia Milk Producers' Association, Inc., Washington, D. C. and Rochester Dairy Cooperative, Rochester, Minn.

Table 4.—Characteristics of typical large, medium, and small markets

Plant size by number of producers	Average testing cost per sample in cents [1]	Large market [2]			Medium market [2]			Small market [2]		
		Number of		Proportion of all producers in percent	Number of		Proportion of all producers in percent	Number of		Proportion of all producers in percent
		Plants	Producers		Plants	Producers		Plants	Producers	
Less than 100	12.5	11	550	4.8	6	300	22.2	6	300	100.0
100–199	10.0	13	1,950	17.1	3	450	33.3	.....	.....	.....
200–299	11.7	8	2,000	17.5	1	250	18.5	.....	.....	.....
300–399	8.7	6	2,100	18.4	1	350	26.0	.....	.....	.....
400–499	10.0	8	3,600	31.7	.....	.....	.....	.....	.....	.....
500 and over	8.3	2	1,200	10.5	.....	.....	.....	.....	.....	.....
Total	.....	48	11,400	100.0	11	1,350	100.0	6	300	100.0

[1] Average testing cost is obtained from Table 3.
[2] Size of the market is in terms of the number of producers averaging 400 pounds per day.

Other Publications Available

Farmer Cooperatives in the United States. FCS Bulletin 1.

Selling Milk . . . Ideas for Cooperative Managements. FCS General Report 20. *Donald E. Hirsch.*

Developing Butterfat Sampling and Testing Programs. FCS Bulletin 5. *Homer J. Preston.*

Pricing Milk According to Use. FCS Bulletin 6. *Stanley F. Krause.*

Milk Distribution Costs of Georgia Cooperatives. FCS General Report 16. *Donald E. Hirsch.*

Fall Premium Milk Pricing Plans. FCS Circular 4. *Norris T. Pritchard.*

Estimating the "Market Value" of a Milk Distributing Business. FCS General Report 3. *Donald E. Hirsch.*

Butterfat Sampling in Bulk Handling and Comparative Milk Solids Losses. FCS General Report 10. *Homer J. Preston.*

Progress in Farm-to-Plant Bulk Milk Handling. FCS Circular 8. *Noel Stocker.*

A copy of these publications may be obtained upon request while a supply is available from the

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